

Sentinel-1 IW DP measurements to extract the coastline in Terra Nova Bay, Antarctica

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INTRODUCTION

This study aims at analyzing the time variability of the Drygalski ice tongue (DIT) coastline using a time series of Sentinel-1 interferometric wide swath (IW) C-band synthetic aperture radar (SAR) imagery in the period 2016-2021. The analysis focus on meaningful features that include the DIT edge and some surface fractures that appeared along both sides of the DIT.

STUDY AREA

The DIT is one of the largest ice tongues in Antarctica. It is located in East Antarctica in Victoria Land and extends to the Ross Sea ($75^{\circ}24'S$, $163^{\circ}30'E$), see **Figure 1**.

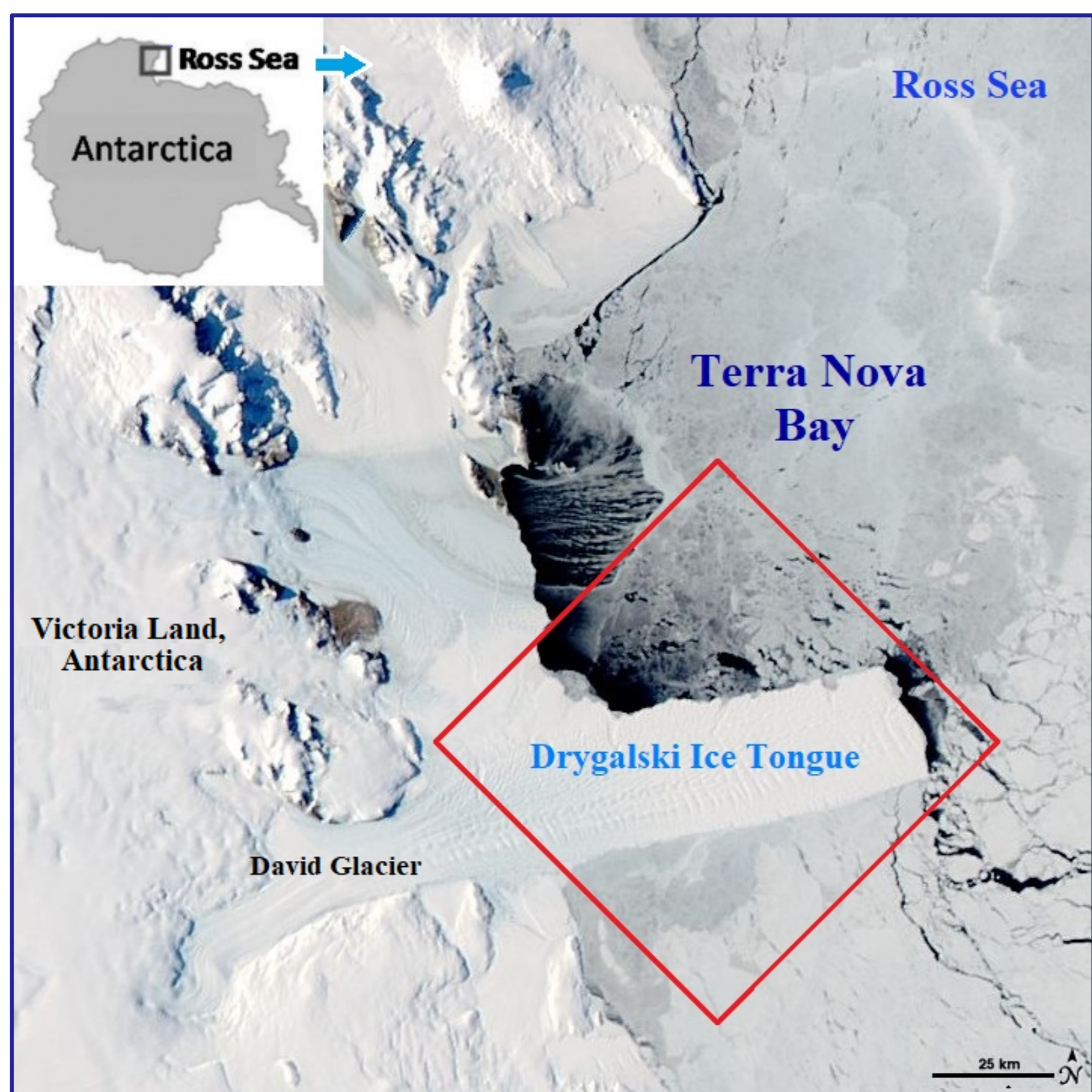


Figure 1. Map of study area [1].

DATASET

Six Sentinel-1 SAR data scenes collected between 2016 and 2021 are processed. A sample of a false-color composite image of a Sentinel-1 SAR image acquired over the DIT is shown in **Figure 2**. The main features of the SAR data set are described in **Table 1**.

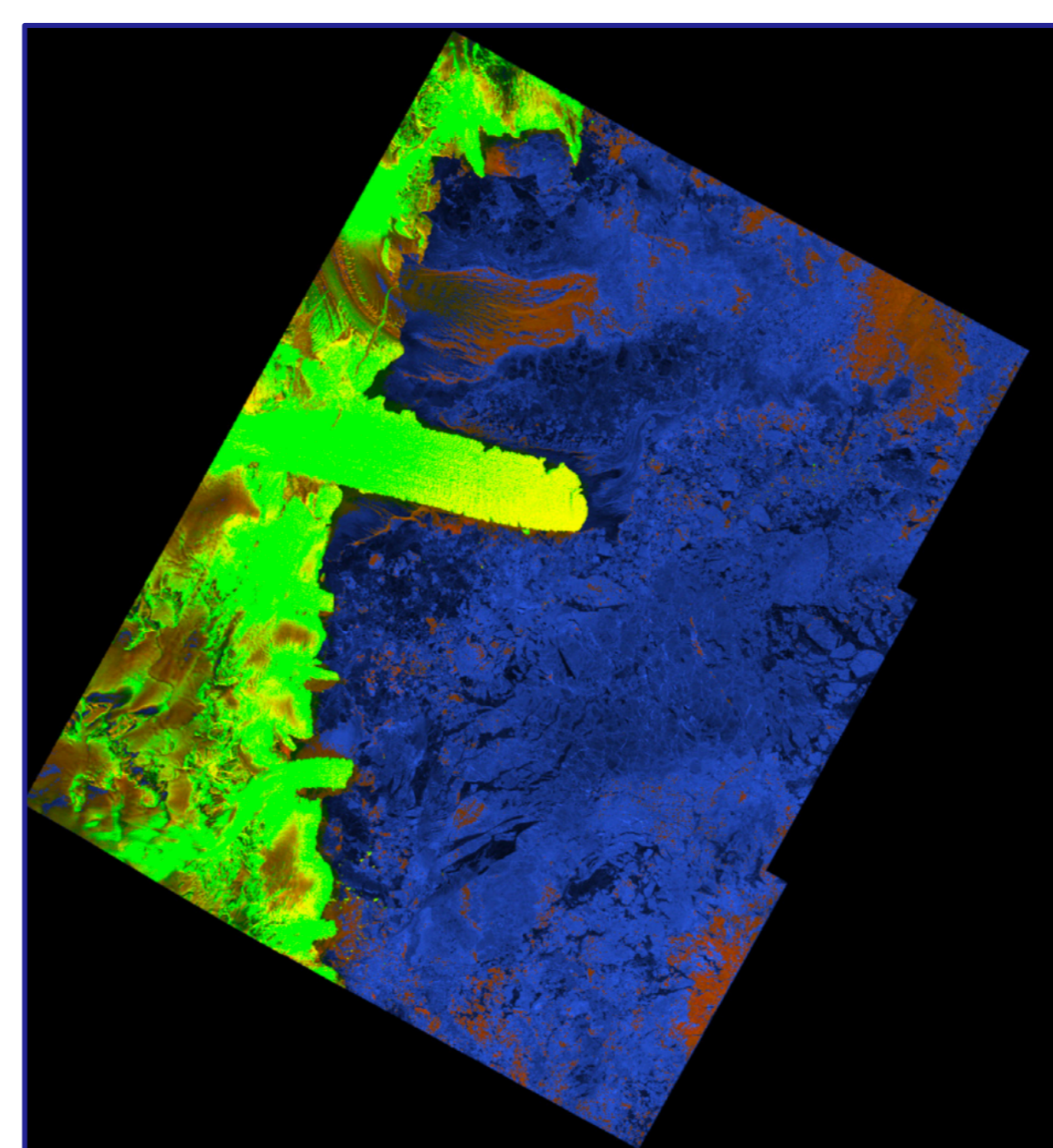


Figure 2. Sentinel-1 false-color composite image of the DIT.

Sensor	Sentinel-1
Mode	IW
Polarization	HH+HV
Pixel spacing (m)	14
Period	2016-2021

Table 1. SAR data set.

METHODOLOGY

The methodology for extracting the DIT profile and analysing its time variability is shown in the processing chain flowchart of **Figure 3** [2]. The processing of a sample Sentinel-1 image belonging together with intermediate outputs stemming from the processing chain is shown in **Figure 4**.

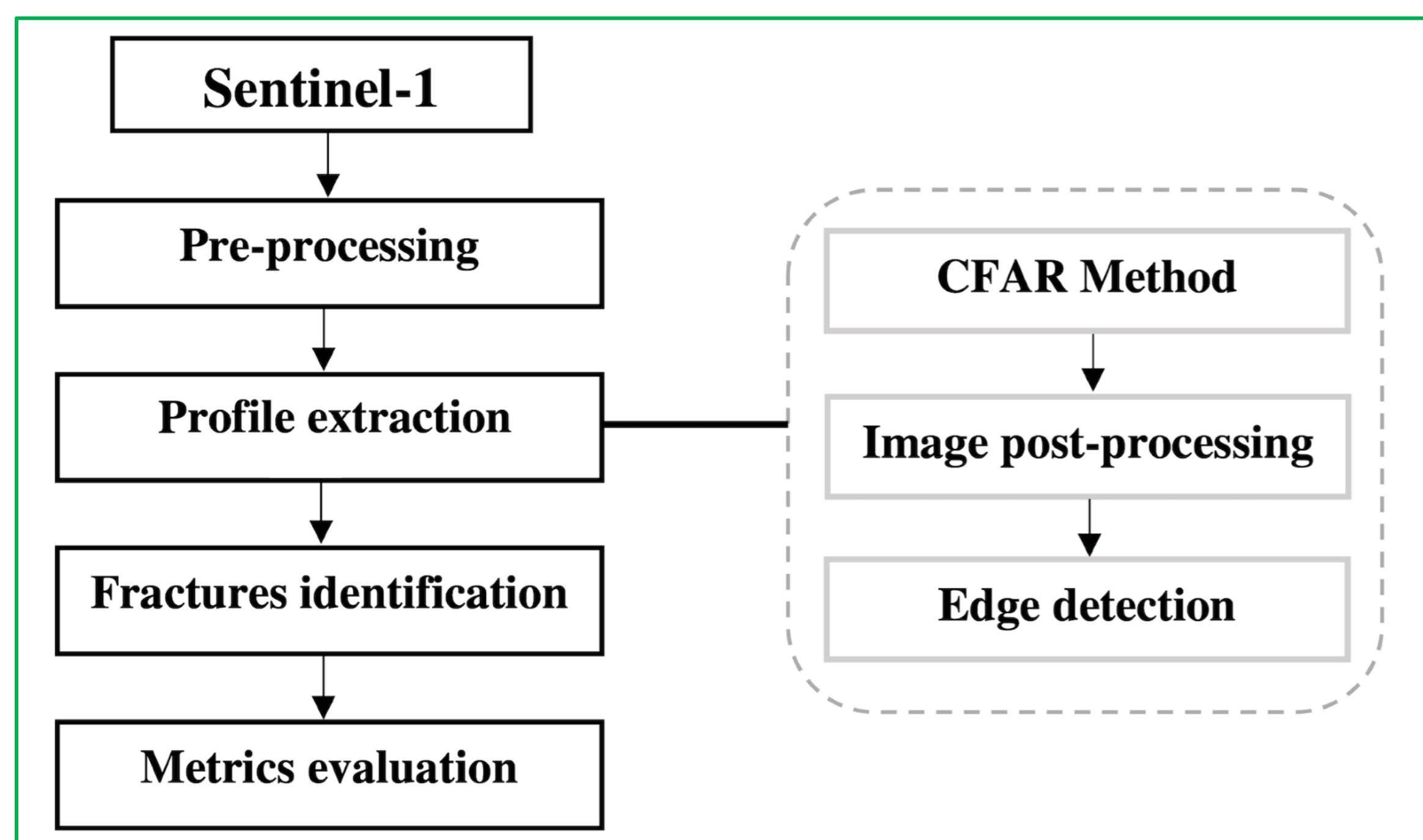


Figure 3. Flowchart of the proposed methodology.

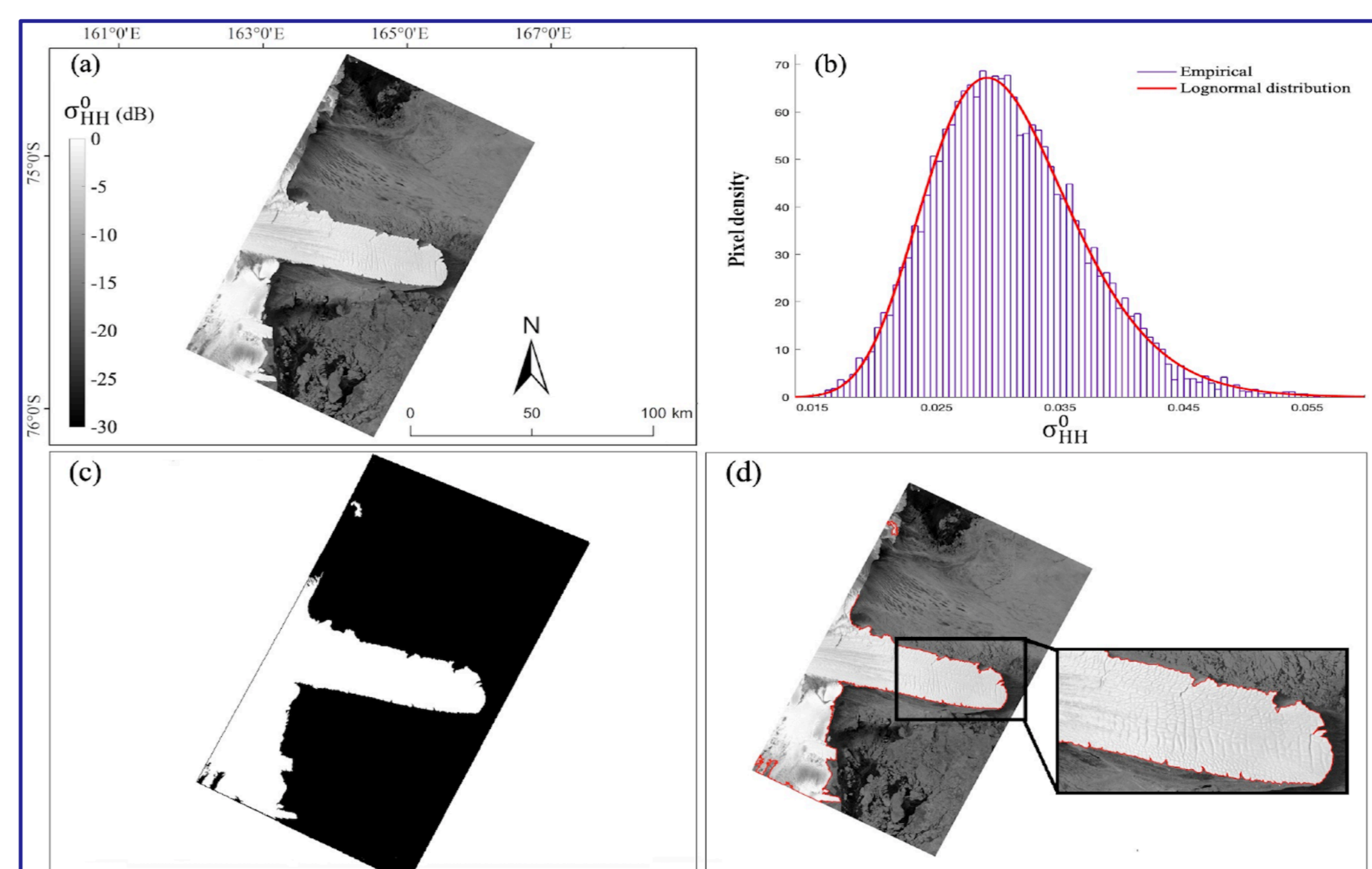


Figure 4. HH-polarized NRCS SAR scene collected on 9 April 2017. (a) Excerpt of the pre-processed SAR scene; (b) empirical pdf of the clutter; (c) binary image obtained using the CFAR method; (d) extracted coastline.

EXPERIMENTAL RESULTS

Results refer to the analysis of the time variability of the DIT morphology, see **Figure 5** and **Figure 6**. Quantitative outcomes relevant to the average surface velocity estimated from the DIT ice front and some highlighted fractures are listed in **Table 2**.

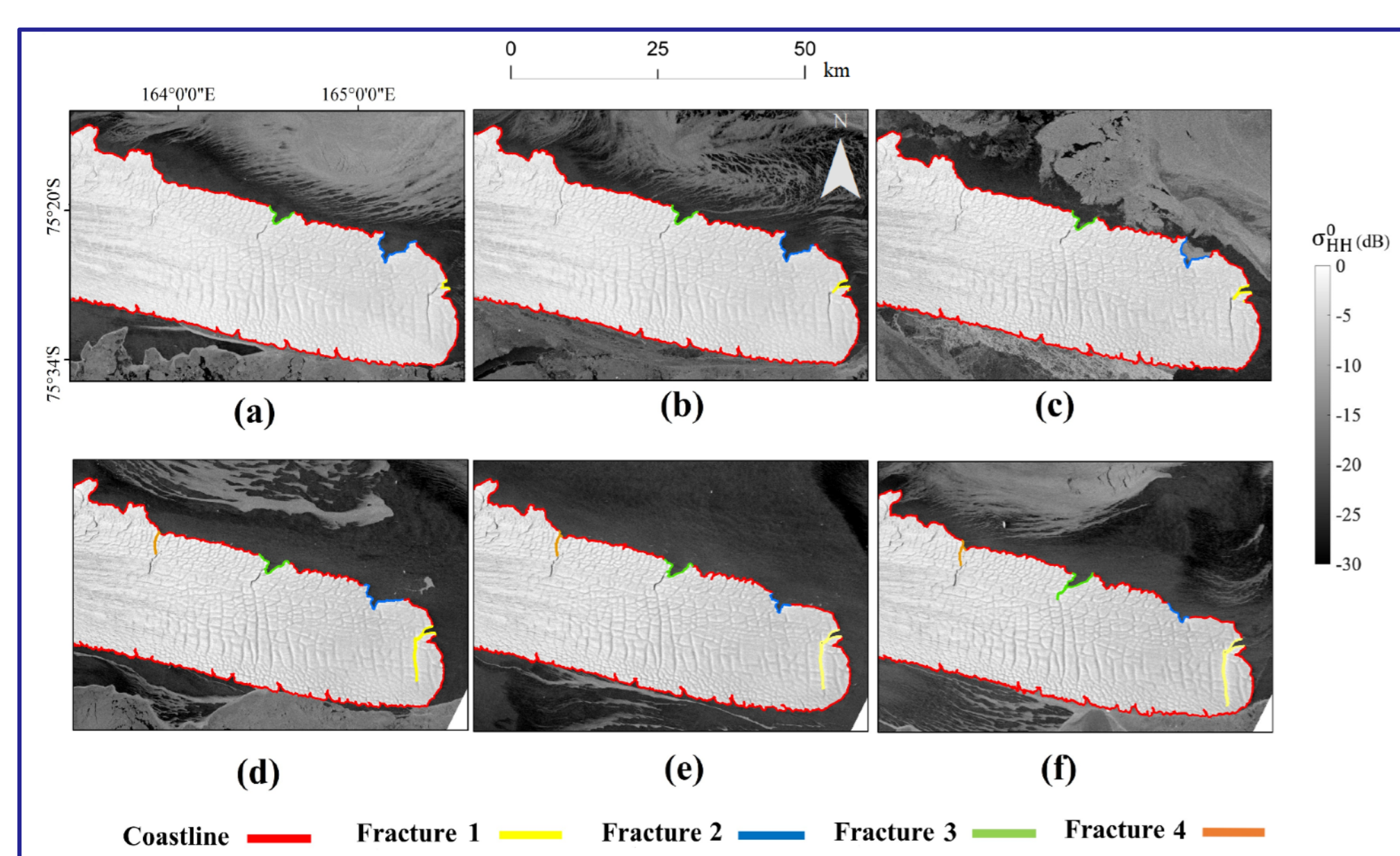


Figure 5. Coastlines extracted from six SAR scenes from 2016 (a) to 2021 (f). The extracted ice tongue profile together with four fractures are also highlighted and marked using different colours.

Feature	Average surface velocity (m per year)
Ice front	675
Fracture 2	663
Fracture 3	614

Table 2. Average surface velocity estimated over the selected features.

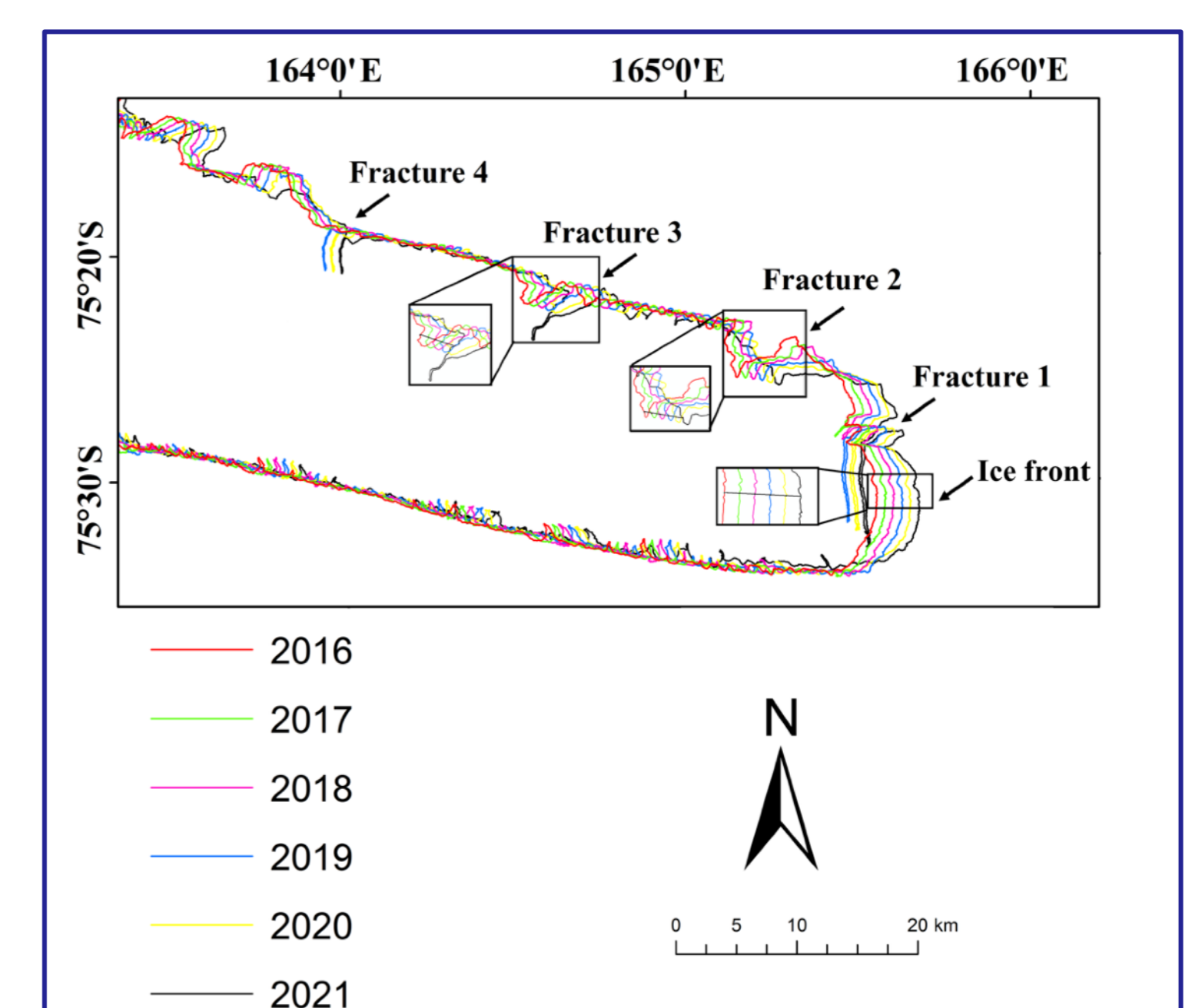


Figure 6. DIT profile extracted over time and depicted using different colours.

CONCLUSIONS

- 1) The proposed methodology is effective and accurate in extracting the Drygalski ice tongue profile
- 2) The features of the Drygalski ice tongue move seaward over time, with the southern (northern) side of Drygalski ice tongue calling for no remarkable change (non-negligible change) in their shape.
- 3) Some rifts appear along the northern side of Drygalski ice tongue in recent years.
- 4) Fractures are characterized by a mean surface velocity of approximately 600 meters per year.

REFERENCES

- [1] G. Aulicino, M. Sansiviero, S. Paul *et al.*, "A new approach for monitoring the Terra Nova Bay polynya through MODIS ice surface temperature imagery and its validation during 2010 and 2011 winter seasons", *Remote Sens.*, vol. 10, no. 3, pp. 366, 2018.
- [2] M., Zahriban Hesari, F. Nunziata, G. Aulicino *et al.*, "Analysis of fine-scale dynamics of the Drygalski ice tongue in Antarctica using satellite SAR data", *Int. J. Remote Sens.*, vol. 43, no. 7, pp. 2602-2619, 2022.